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PREPARATION AND CHARACTERIZATION OF CUO THIN FILMS BY SPRAY PYROLYSIS METHOD FOR VARIOUS APPLICATIONS

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ABSTRACT

Preparation of CuO thin films by spray method is having wide range of applications. In this the CuO films prepared using various concentration of aqueous solution containing CuCl2.2H2O and double distilled water. The XRD, UV-VIS spectra was recorded. XRD results shows that the film is poly crystalline nature. The refractive index, optical band gap, film thickness were calculated by using the UV-VIS spectra. This CuO films are suitable for solar cell fabrications.. Optical spectrum shows that the films are having high transmittance and low absorption in the visible region. Ultra violet-visible spectra shown that the optical energy gaps for CuO films were estimated in the range 1.4 and 1.7 eV.

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INTRODUCTION

Metal oxide thin films have received great attention in the recent days for their special characteristics in optical properties for solar cell fabrication[1]. Moreover CuO is considered as a material in a capacitive type gas sensor for sensing and detecting a large number of gases[2]. Thin films of copper oxide have been prepared using various thin films deposition technique such as chemical vapour deposition, electro-deposition, thermal oxidation and sputtering process[3-5]. The present investigation deals with the study of CuO film prepared by spray pyrolysis. The films have been characterized for structural and optical properties using XRD and spectrophotometry, respectively.

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EXPERIMENTAL DETAILS

CuO thin films were deposited on conduction glass substrate by spraying with different concentration of (0.05M, 0.1M and 0.15M) aqueous solution of CuCl2.2H2O dissolved in double distilled water. The experimental conditions of the spay deposition of films have been summarized in Table 1.

Table 1: *Conditions for the Deposition of CuO Thin Film*

Spray parameter	Values
CuCl2.2H2O	11.4ph-12.6ph
Solvent	Double distilled water
Substrate temperature	400°C
Carrier Gas	Compressed air
Rate of Spray	4ml / m
Angular distance	25cm

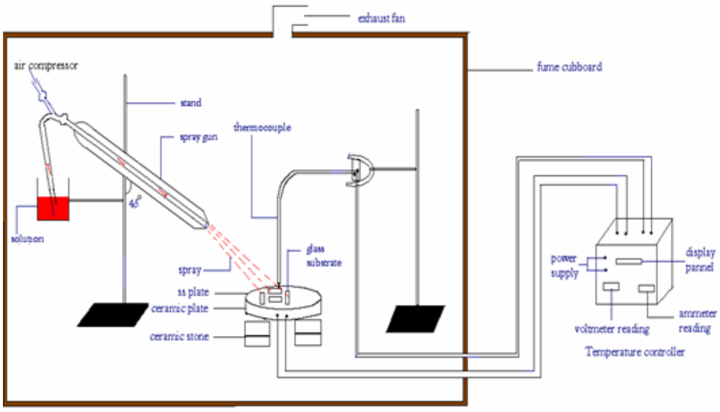

Fig.1. *Schematic diagram of spray pyrolysis experimental setup*

RESULTS AND DISCUSSION

3.1 Structural Characterization

Structural characterization of films was carried out by XRD, employing X-Ray diffractometer (BRUKEL AX S D8), using Cu-Kα wavelength. Fig.1 to Fig. 3 show the X-ray diffraction patterns of film deposited at various mole concentration of aqueous solution The presence of sharp peaks are shown in all diffractograms and reveals that the sprayed CuO thin films are polycrystalline in nature. Results of peak positions observed for the films prepared at three different molar concentrations are compared with ASTM data. The preferred orientation is (111) crystal plane for all composition. The Copper Oxide thin films of different mole concentration are found to exhibit monoclinic in nature[6-7].

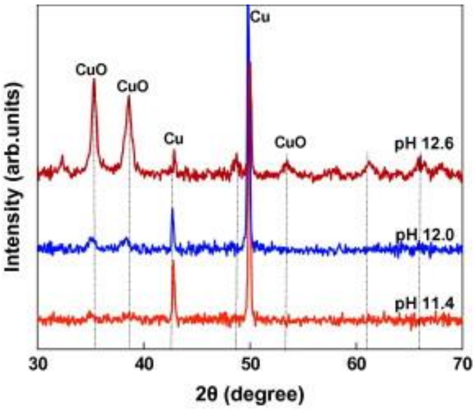

Fig.2: *XRD pattern of CuO films for pH 11.4-12.6*

3.2 Optical Properties

The transmittance studies of the film gives the amount of energy transmitted by the material coated in the film. The optical transmittance spectra were studied in 300 – 1100nm wavelength range by UV – visible spectrophotometer. This type of spectrometer features a continuous change in wavelength and an Automatic comparison of light intensities of sample and reference materials, which is plotted as a function as a function of wavelength.

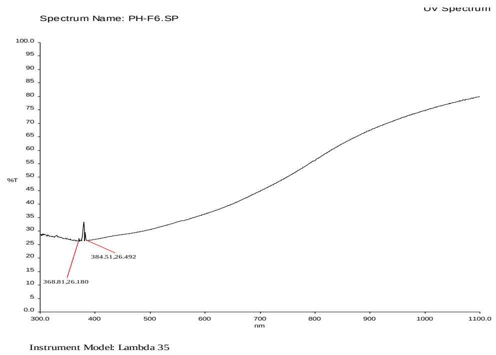

Fig3: *Wave Length vs Transmittance*

The Graph has been drawn for transmittance studies. From the values obtained, graph was plotted between the wavelength and transmittance.

Absorbance has high value of metal, whereas it has low value for dielectrics, semiconductors have inter mediate values between metals and dielectrics. The optical absorption spectra were studied in 300 – 1100nm wavelength range by UV[8] – visible spectrophotometer. This type of spectrometer features a continuous change in wavelength and an Automatic comparison of light intensities of sample and reference materials, which is plotted as a function as a function of wavelength. The graph have been plotted between the wavelength and absorbance for sample of CuO.

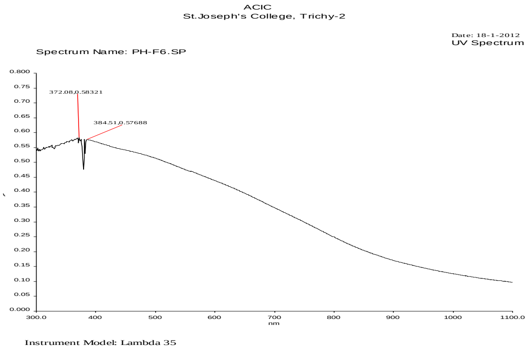

Fig:4 *Absorbance vs Wavelength*

3.3 Band Gap Studies:

The optical energy band gap was calculated from the absorption values of the different samples. Band gap is the energy gap between the conduction band and the values band is of the order of electron volt eV. Here the estimation was done from the position of the absorption edge. In order to estimate the energy band gap values for the sample calculators were made from the recorded absorption values. The absorption coefficient is calculated using the formula α=2.303*Abs./t and with the photon energy hv, the values of hvα and $(hv\alpha)^2$ were also found for the sample[9-11]. The graphs drawn between the linear dependence of variation in absorption coefficient as a product of incident photon with the photon energy i.e. of hv vs (hvα) and from the graph the band gap value has been found 1.5ev-1.76ev[10-12].

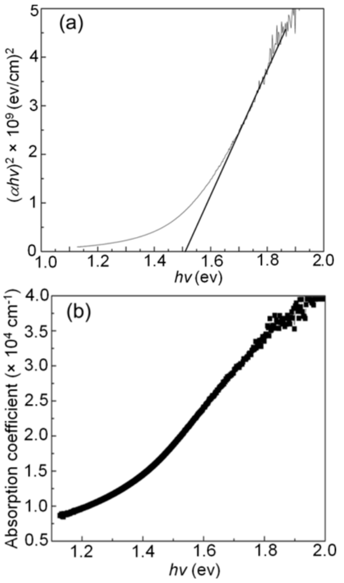

Fig 5: *Graph for Calculating Band gap*

Table 2: *Wave Length and Absorption Coefficient*

Wave length(nm)	%of Transmittance	α -absorption coefficient	Energy(hv)	hvα
350	1675.4	7851726.305	4.15625	32633737.46
400	2366.5	8216993.495	3.93359375	32322314.25
450	2960.2	8453740.997	3.496527778	29558740.22
500	3482.3	8625540.216	3.146875	27143496.87
550	4092.8	8796387.743	2.860795455	25164666.07
600	4572.5	8913606.96	2.622395833	23375005.75
650	5071.5	9023153.793	2.420673077	21842105.45
700	5601.3	9128243.25	2.247767857	20518171.77
750	6119.7	9221859.709	2.097916667	19346693.18
800	6694.4	9316791.787	1.966796875	18324236.97
850	7244.3	9400285.808	1.851102941	17400896.71
900	7670.3	9460720.261	1.748263889	16539835.6
950	7997.2	9504861.723	1.65625	15742427.23
1000	8263.9	9539557.811	1.5734375	15009897.99
1050	8483.4	9567283.545	1.498511905	14336688.29
1100	8654.6	9588414.86	1.430397727	13715246.82

From the optical data the extinction co-efficient (Kf) and absorption co-efficient(α) are measured. Fig. 6 shows the variation of extinction co-efficient with the wavelength. It shows that it decreases with increasing wavelength.

The absorption co-efficient is minimum at lower energy and increases with increasing optical energy. It also shows the linear variation at the absorption edge. It reveals that the optical transition of the film is direct allowed transition[13]. Fig. 5 shows the variation of $(\alpha hv)^2$ as the incident photon energy (hv) of CuO films at different molar concentrations. When the linear portion of the graph is exactly plotted the intercept of X - axis gives the band gap values of those films.

CONCLUSION

Copper oxide thin films have been prepared by chemically spraying of aqueous solution of copper chloride and their deposition conditions are optimized. The films are polycrystalline in nature. The texture of the films are found to be in (1 1 1) plane[14-16]. The structure of the films is monoclinic. The molar concentration of the films affects the thickness and optical properties of the films. The transmittance increases with decrease in concentration of the films. The refractive index value which is got through the u-v spectrum is 1.5062. The optical band gap was also found to be 1.76 eV. Hence CuO thin films are suitable for solar cell applications.

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